Arquivos do Museu Nacional, Rio de Janeiro, v.63, n.1, p.169-174, jan./mar.2005
ISSN 0365-4508

THE KARYOTYPES OF *TRINOMYS MOOJENI* (PESSÔA, OLIVEIRA & REIS, 1992) AND *TRINOMYS SETOSUS ELEGANS* (LUND, 1841) (RODENTIA, ECHIMYIDAE) FROM MINAS GERAIS, EASTERN BRAZIL [1]

(With 2 figures)

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ABSTRACT: Two new karyotypes of species in the genus *Trinomys* are described from specimens collected recently in Morro do Pilar and Santa Bárbara, Minas Gerais State (MG), Brazil. *Trinomys moojeni* from Morro do Pilar had 2n=56 and FN=106 and *T. setosus elegans* from Santa Bárbara had 2n=56 and FN=104. Besides the differences in FN, different morphologies in the sex chromosomes also had been detected. These results at chromosomal level corroborate findings from the mitochondrial genome that suggest that *T. s. elegans* belongs to a clade composed by *T. s. setosus* and *T. s. denigratus*. The chromosomal data corroborated the inclusion of *T. moojeni* in this clade, as previously suggested on the basis of cranial morphology evidence.

Key words: *Trinomys moojeni*, *Trinomys setosus elegans*, cytogenetic data, cranial and bacular characters, qualitative analysis, Minas Gerais.

RESUMO: Os cariótipos de *Trinomys moojeni* (Pessôa, Oliveira & Reis, 1992) e de *Trinomys setosus elegans* (Lund, 1841) (Rodentia, Echimyidae) de Minas Gerais, leste do Brasil.

Dois novos cariótipos são descritos para espécies do gênero *Trinomys* com base em coletas recentes nos municípios de Morro do Pilar e Santa Bárbara no Estado de Minas Gerais (MG). *Trinomys moojeni* de Morro do Pilar apresentou o cariótipo com número diplóide (2n) igual a 56 e número fundamental (NF) igual a 106 e *T. setosus elegans* de Santa Bárbara apresentou 2n=56 e NF=104. Além da diferença nos valores de NF, diferenças na morfologia cromossômica do par sexual também foram detectadas. Os resultados no nível cromossômico corroboram aqueles encontrados com base no genoma mitocondrial, que evidenciou que *T. s. elegans* pertence a um clado composto por *T. setosus setosus* e *T. s. denigratus*. Os dados cromossômicos corroboraram a inclusão de *T. moojeni* neste clado, como previamente sugerido com base em evidências da morfologia craniana.

Palavras-chave: *Trinomys moojeni*, *Trinomys setosus elegans*, dados citogenéticos, caracteres cranianos e baculares, análise qualitativa, Minas Gerais.

INTRODUCTION

Trinomys moojeni (Pessôa, Oliveira & Reis, 1992), was described on the basis of a series of seven individuals collected in August 1954 by Professor Cory T. Carvalho in Mata Dr. Daniel and Boca da Mata (Conceição do Mato Dentro, Minas Gerais, Brazil), during an expedition to the Serra do Cipó, Minas Gerais. This material was later deposited in the mammal collection of the Museu Nacional - Rio de Janeiro, and originally identified on the labels as "*Proechimys setosus*"(Desmarest, 1817).

When analyzing cranial and bacular morphology in *Trinomys* Thomas, 1921, PESSÔA & REIS (1992) found that the baculum was useful as a morphological marker for the species described in the genus. A detailed comparison of the cranial

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and bacular morphology of the Serra do Cipó sample and of specimens of *Trinomys setosus elegans* (Lund, 1841) from Peti, MG, deposited at the Universidade Federal de Minas Gerais, enabled PESSÔA, OLIVEIRA & REIS (1992) to describe the sample as a new species, *T. moojeni*. Cranial and bacular structures together with pelage traits were used to distinguish *T. moojeni* from the other species within *Trinomys* then a subgenus of *Proechimys* Allen, 1899.

No further specimens of *T. moojeni* were found for half a century, until PASCHOAL *et al.* (2004) collected new individuals of this species during a field trip to Morro do Pilar, 20km from Conceição do Mato Dentro, near to the type locality of the species. These finds provided an opportunity to investigate the diploid number (2n) and fundamental number (FN) of *T. moojeni*.

Trinomys elegans was originally described as *Echimys elegans* Lund, 1841, from Lagoa Santa, Minas Gerais. MOOJEN (1948), in his standard taxonomic structure of *Proechimys*, considered *P. setosus* to be polytypic with two subspecies: *P. setosus setosus* and *P. setosus elegans*. In a recent study using mitochondrial haplotypes of individuals from Minas Gerais, LARA & PATTON (2000) kept *T. setosus* as polytypic and included a third subspecies, *T. s. denigratus* Moojen, 1948.

During a recent expedition to Santa Bárbara, located approximately 100km from Lagoa Santa, State of Minas Gerais, four *Trinomys* specimens were collected. Detailed observation of their pelage and cranial and bacular morphology led to their identification as *T. s. elegans*. These specimens were also studied cytogenetically in order to investigate their diploid and fundamental numbers and to describe their karyotype.

The objective here is to describe the karyotypes of *T. moojeni* and *T. s. elegans* from Morro do Pilar and Santa Bárbara, State of Minas Gerais. Specifically we want to investigate whether karyotype characters can be used to diagnose the two species and whether they allow these two species to be assigned to the clades within *Trinomys* recently defined on the basis of mitochondrial haplotypes and cranial morphology (LARA & PATTON, 2000).

MATERIAL AND METHODS

Two specimens of *Trinomys* collected in Morro do Pilar, Serra do Cipó, Minas Gerais (19°12'56"S-43°22'35"W, 622m) (PASCHOAL *et al.*, 2004) were compared with the type series of *T. moojeni* in the mammal collection of the Museu Nacional, Rio de Janeiro (MN), and were identified as belonging to the same species. The voucher material consists of one skull and one skull and skin, and is lodged in the mammal collection of the Museu de Ciências Naturais da PUC, Minas Gerais (specimen numbers MCN-M 971 and MCN-M 985, respectively). Four *Trinomys* specimens collected in Santa Bárbara (19°53'19"S-43°22'26"W, 721m) were diagnosed as *T. setosus elegans* on the basis of pelage, and cranial and bacular morphology, and are kept in the mammal collection of the Museu Nacional (specimen numbers MN 68152, MN 68153, MN 68154, MN 68155).

Cytogenetic analyses were performed on mitotic metaphase chromosomes from bone marrow of one male *T. moojeni* (MCN-M 985) and one male and two females *T. s. elegans* (MN 68152, 68153 and 68154, respectively), following FORD & HAMERTON (1956) with modifications. Chromosomes were stained with Giemsa and classified according to LEVAN, FREDGA & SANDBERG (1964). A total of 47 metaphase cells of *T. moojeni* and 62 of *T. s. elegans* were analyzed. Metacentric, submetacentric, and subtelocentric chromosomes are considered biarmed and acrocentric ones uniarmed.

RESULTS

Cytogenetic analyses of *T. moojeni* revealed a diploid number 2n=56 and fundamental number FN=106. This karyotype comprises 26 pairs of metacentric, submetacentric, and subtelocentric autosomes and one pair of acrocentric autosomes (pair 27). The X chromosome is a large submetacentric corresponding in size to pair 2. The Y chromosome is a medium-sized metacentric intermediate between pairs 15 and 16 (Fig.1).

Trinomys setosus elegans displayed 2n=56 and FN=104. This karyotype consists of 25 pairs of metacentric, submetacentric, and subtelocentric autosomes and two pairs of acrocentric autosomes (pairs 26 and 27). The X chromosome is a large acrocentric corresponding in size to the third pair. The Y chromosome is acrocentric and one of the smallest chromosomes in the set (Fig.2).

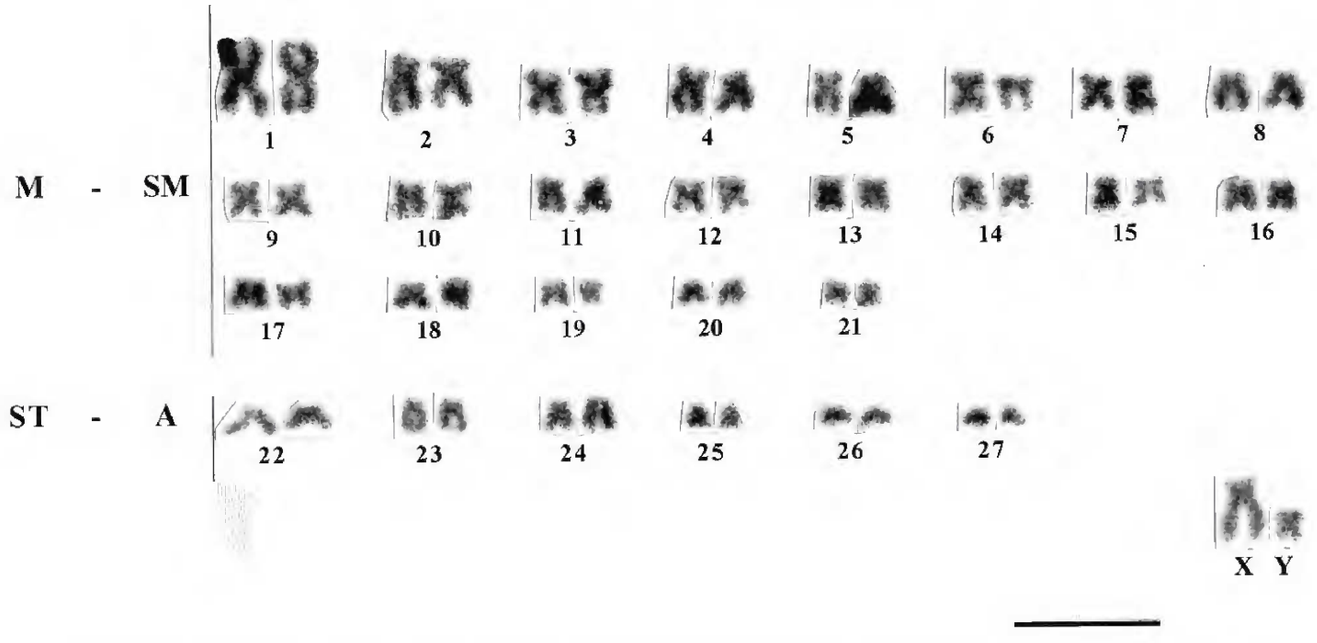

Fig.1- Karyotype of male of *Trinomys moojeni* (MCN-M 985) (2n=56, FN=106) from Morro do Pilar, MG. Scale bar = 10μm.

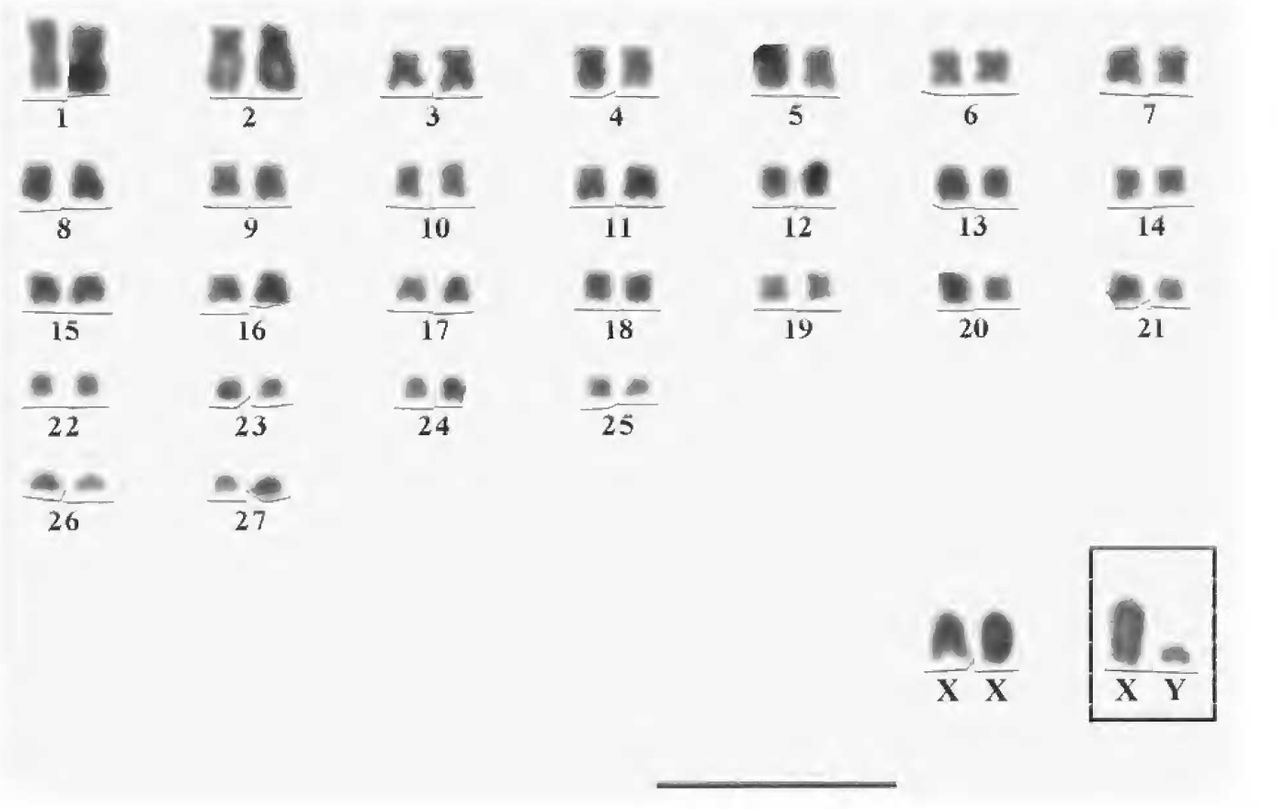

Fig.2- Karyotype of female of *Trinomys s. elegans* (MN 68153) (2n=56, FN=104) from Santa Bárbara, MG, and XY (inset) of a male specimen (MN 68152). Scale bar = 10μm.

Table 1. Cytogenetic data for taxa in the genus *Trinomys* and association with mitochondrial clades.

TAXA	MITOCHONDRIAL CLADES	2n	FN	M-SM	ST-A	X	Y	LOCALITY	REFERENCE
T. dimidiatus	Clade1	60	116	29	-	SM	M	Ubatuba SP	PESSÔA *et al.*, 2005
T. dimidiatus	Clade1	60	116	29	-	SM	M	Rio Bonito RJ	PESSÔA *et al.*, 2005
T. iheringi	Clade1	61-65	116	29	-	SM	SM	four localities SP	YONENAGA-YASSUDA *et al.*, 1985
T. g. gratiosus	Clade1	56	108	27	-	SM	-	Venda Nova ES	ZANCHIN, 1988
T. g. bonafidei	Clade1	56	108	27	-	SM	M	Teresópolis RJ	PESSÔA *et al.*, 2005
T. yonenagae	Clade2	54	104	26	-	A	M	Ibiraba BA	LEAL-MESQUITA *et al.*, 1992
T. eliasi	Clade2	58	112	28	-	SM	M	Maricá RJ	PESSÔA *et al.*, 2005
T. s. elegans	Clade 2	56	104	25	2	A	A	MG	Present study
T. moojeni	"Clade2"	56	96	21	6	SM	M	Morro do Pilar MG	Present study
T. albispinus	Clade3	60	116	29	-	SM	A	Morro do Chapéu BA	LEAL-MESQUITA *et al.*, 1992

(2n) diploid number, (FN) fundamental number, (X) X-chromosome, (Y) Y-chromosome, (M) metacentric, (SM) submetacentric, (ST) subtelocentric, (A) acrocentric.

DISCUSSION

THOMAS (1921) described *Trinomys* as a subgenus of *Proechimys* on the basis of the number of counterfolds in the upper molariform teeth: four in the subgenus *Proechimys* and three in the subgenus *Trinomys*. The subgenus *Proechimys* encompassed all species occurring in Central America, the Amazon Basin, and Central Brazil, as well as one species, *P. iheringi* Thomas, 1911, from the Atlantic forest in south-eastern Brazil (THOMAS, 1921). MOOJEN (1948) observed, however, that in all the forms allocated by Thomas to the subgenus *Proechimys*, except for *P. iheringi*, the main fold in the molariform teeth is short, whereas in the remaining forms this fold extends entirely across the occlusal surface of the tooth. MOOJEN (1948) used primarily this character to define each of the subgenera, and not the number of cheekteeth counterfolds as suggested by Thomas. He also claimed that the number of folds was variable at subspecific level in his standard taxonomic arrangement. According to MOOJEN's (1948) definition, the two subgenera (*Proechimys* and *Trinomys*) not only are morphologically differentiated but also occupy distinct geographic ranges. A recent study based on evidence from molecular sequences sampled from the mitochondrial genome indicated that the subgenus *Trinomys* as conceived by MOOJEN (1948) does not share a most recent common ancestor with *Proechimys*, suggesting that it should be granted generic status in its own right (LARA & PATTON, 2000). These authors based their taxonomic structure for *Trinomys* on the phylogenetic relationships of a haplotype lineage derived from 726 base pairs of the cytochrome-*b* gene. They recognized three major clades in this structure, encompassing the majority of the taxa recognized by MOOJEN (1948); only *Proechimys iheringi panema* Moojen, 1948, and *T. moojeni* were not sampled for molecular sequences in their study. Although they did not have sequence data for *T. moojeni*, LARA & PATTON (2000) suggested on the basis of cranial morphology that

it should be included in their clade 2, which also encompasses *T. s. setosus*, *T. s. elegans*, and *T. s. denigratus*.

Four other diploid numbers for the genus have been described in the literature and may be allocated to the following molecular clades: *T. yonenagae* (Rocha, 1995), from Ibiraba, Bahia (clade 2), with 2n=54 (FN=104); *T. albispinus* (Is. Geoffroy, 1838), from Morro do Chapéu, Bahia (clade 3), with 2n=60 (FN=116); *T. iheringi* from four localities in State of São Paulo (clade 1), with 2n=61-65 (due to the presence of 1 to 5 supernumerary chromosomes); and *T. gratiosus gratiosus* (Moojen, 1948) from Venda Nova, Espírito Santo (clade 1), with 2n=56 (FN=108) (LEAL-MESQUITA *et al.*, 1992; YONENAGA-YASSUDA *et al.*, 1985; ZANCHIN, 1988). Further diploid numbers are reported by PESSÔA *et al.* (2005). It can be seen from these data together with the details obtained in this study (Tab.1) that each taxon has some chromosomal character that may be used to diagnose it as a unit and differentiate it from the others.

The diploid numbers described here for *T. moojeni* and *T. s. elegans* in Minas Gerais State (2n=56) are identical, but the fundamental numbers (FN=106 and FN=104, respectively) and the morphology of sex chromosomes can be used to diagnose them. These two taxa share chromosomal characters, suggesting that they are more closely related to each other than to any other species in the genus. The results for *T. s. elegans* at the chromosomal level corroborate the findings from the mitochondrial genome, which place the taxon in clade 2 (LARA & PATTON, 2000). The chromosomal data also confirm that *T. moojeni* must be part of clade 2, as suggested by LARA & PATTON (2000) on the basis of cranial morphology.

ACKNOWLEDGEMENTS

We thank the curators for permission to study the type specimens and for their hospitality during visits to the Museu Nacional; Stella Maris Franco (Museu Nacional - Rio de Janeiro – MN), for help with specimens and information; Dr. Christopher J. Tribe (University Museum of Zoology, Cambridge) kindly revised a previous version of this manuscript and provided valuable comments. We are also grateful to the administration and staff of the Parque Nacional da Serra do Cipó for granting permission and providing support to study the small mammals in the reserve area. Fundação O Boticário de Proteção à Natureza and FIP/PUC-Minas (Fundo de Incentivo à Pesquisa) provided financial support. Work by the authors was funded by grants from the Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ-E-26/170.547/99). L.M.Pessôa was partially supported by a fellowship from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq-301386-927). A collecting licence was granted by the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA).

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